NAVAL AIR WARFARE CENTER AIRCRAFT DIVISION
PATUXENT RIVER, MARYLAND

REPORT OF TEST RESULTS

REPORT NO: NAWCADPAX/RTR-2000/97

S-3B SMALL-SCALE APPLIQUÉ COUPON FLIGHT TEST EVALUATION RESULTS

by

Wm. Eric Werking
Jeffery A. Kuhlman, LCDR, USN

9 January 2001

DEPARTMENT OF THE NAVY
NAVAL AIR WARFARE CENTER AIRCRAFT DIVISION
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14. ABSTRACT

An evaluation of FP500 and FP1500 paint replacement film (appliqué) small-scale coupons with 52-4 adhesive installed on the S-3B aircraft was conducted during 225 hr of laboratory tests and 2 flights totaling 2.0 flight-hours to determine system suitability for large-scale coupon evaluation. Complete adhesion of the film to the surface of the aircraft during basic maneuvers is an enhancing characteristic that will promote reliable performance of FP500 and FP1500 appliqué material reducing corrosion and maintenance down time aircraft. Tattering of prepeeled (failed) sections of the appliqué was an enhancing characteristic that will prevent any in-flight failures from becoming catastrophic failures. The capability of the adhesive to adhere to the film and not the aircraft surface during appliqué removal is an enhancing characteristic that will facilitate the rapid removal of the appliqué. There are no deficiencies.

15. SUBJECT TERMS

S-3B; Small-Scale; Appliqué

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SUMMARY

The purpose of this test was to evaluate the adhesive characteristics of 3M FP500 and FP1500 matte finish aircraft appliqué film with 52-4 adhesive and ensure that the FP500 and FP1500 film behaved in a similar manner on the S-3B aircraft for follow-on large-scale coupon tests. Two flights, totaling 2.0 flight-hours, and 225 hr of laboratory tests were conducted at NAWCAD Patuxent River, Maryland. Test flights were conducted during daylight visual meteorological conditions. All test objectives were met.

The test airplane, BuNo 160607, was fleet representative for the purposes of this test. The flight tests were conducted with two crew and within the weight, center of gravity, and flight envelope of the aircraft. The appliqué material and adhesive were not tested in visual moisture.

The FP500 and FP1500 paint replacement films with 52-4 adhesive performed adequately with and without prepeeled edges under all flight maneuvers tested. No coupons failed or otherwise separated from the skin of the aircraft. During prepeeled tests (to investigate failure modes), the coupons tattered instead of peeling further or separating from the aircraft skin. During removal of the appliqué coupons, the 52-4 adhesive remained on the coupon and not on the skin of the aircraft which will facilitate repairs of film.

The FP500 and FP1500 appliqué materials with 52-4 adhesive are satisfactory for continued large-scale testing.

Contents

INTRODUCTION

BACKGROUND

1. The S-3 Small-Scale Appliqué Coupon Flight Test Evaluation program is a continuation of the Paintless Aircraft program, the objective of which is to validate a series of film technologies as a replacement for paint on aircraft. The original sponsor of the program was the Department of Commerce with Lockheed Martin and 3M Corporation. The S-3 participated in Phase I evaluation of the appliqué material coupon testing in 1996, followed by large-scale testing (30% coverage of the empennage) in 1997. In both tests, the appliqué material was applied over properly prepared paint (TT-P-2756 Self-Priming Topcoat) on a fleet aircraft, and the tests were successfully completed. In August 1998, Commander, Sea Control Wing Atlantic and NAVAIRSYSCOM agreed to conduct a full-scale test (95% coverage) to commence in February 1999. The full-scale installation was completed in March 1999 with subsequent flight evaluation.

2. Numerous failures were incurred during the flight. These failures were investigated to determine possible causes, and develop possible solutions. The main cause was found to be insufficient surface preparation, which resulted in excessive surface roughness. This greatly reduced the adhesion of the appliqué to the surface of the aircraft. Other failures resulted from pressurized air, escaping from within the aircraft, becoming trapped beneath the appliqué and forming bubbles. A more rigorous surface preparation process was developed to smooth and clean the surface prior to installing appliqué. Perforated film was developed to allow any trapped air to escape through the film. An improved adhesive was also developed.

3. The program is currently in a recovery phase, during which the appliqué will be applied over properly prepared surfaces at locations where the previous failures occurred. In an effort to better understand previous failures and evaluate the solutions developed, testing will be conducted with the appliqué material applied over TT-P-2756 Self-Priming Topcoat, which was the same material over which it had been applied during previous testing. NAWCAD Patuxent River, Maryland, was tasked, via reference 1, to provide the Paintless Aircraft program with test and evaluation support for ground and flight tests during the recovery phase.

PURPOSE

4. The purposes of this test were to evaluate the adhesive characteristics of 3M FP500 and FP1500 matte finish aircraft appliqué film with 52-4 adhesive and ensure that the FP500 and FP1500 film behaved in a satisfactory manner on the S-3B aircraft for follow-on large-scale coupon tests. Failure modes (the behavior following a failure) of the appliqué were also investigated. The results of the small-scale coupon tests will be used in the planning of follow-on large-scale coupon tests.

DESCRIPTION OF AIRPLANE AND EQUIPMENT

5. The S-3B is a high-wing, jet powered, twin-engine, carrier-based airplane operating in the 35,000 to 50,000 lb gross weight class with folding wings, folding vertical fin, a launch bar, and a tailhook to support shipboard operations. The airplane performs surface surveillance and surface warfare missions in support of the Carrier Battle Group. The airplane is powered by two General Electric axial flow TF34 high-bypass turbofan engines installed on pylons mounted under the wing, inboard of the wingfold stations. The test aircraft was S-3B, BuNo 160607, and may be considered a fleet representative aircraft for the purposes of this test. No special instrumentation was required. A complete description of the aircraft can be found in reference 2.

6. The FP500 appliqué material was approximately 5 mils thick with a density of 0.05 lb/ft^2. The FP1500 appliqué material was approximately 5 mils thick with a density of 0.046 lb/ft^2. The FP1500 material differed from the FP500 material in that it had a higher modulus of elasticity, slightly higher strength, and slightly higher Shore hardness. Both materials were pigmented to FED-STD-36375. The 52-4 adhesive was applied to the back of the appliqué, and covered with a plastic backing, which was peeled off prior to installation. Unperforated and perforated coupons were used, the perforated coupons having 7-10 mil diameter holes in a ½ in. grid pattern.

SCOPE

7. Approximately 225 hr of laboratory testing was conducted by 3M and AIR 4.3.4.1, Materials Protection Branch, to determine the adhesion, fluid resistance, and weathering characteristics of the appliqué. A description of the laboratory tests is contained in table A-1. The results of the laboratory tests conducted are contained in references 3 and 4. The appliqué passed all laboratory tests that were required for coupon installation and flight testing.

8. Flight testing was conducted during two flights, totaling 2.0 hr. The flights were conducted during daylight visual meteorological conditions within the Patuxent River restricted areas. Test maneuvers covered regions of the S-3B envelope that provided the highest aerodynamic loads upon the coupon sites. Flight one investigated the appliqué for integrity under varying aerodynamic and pressurization changes around the aircraft as well as the impact of cycling doors under aerodynamic loads. Flight two was conducted with prepeeled sections to investigate tattering or additional peeling (failure modes) of the appliqué. The flight sequence and tests conducted are presented in table 1.

Table 1: Flight Test Sequence

Flights	Scope of Tests	Sample Tests	Coupon Edge Condition
1	Basic Flight Operations	Takeoffs, Climbs, Maneuvers at Altitude, Descents, Approaches, Landings	No prepeeled edges (Initial tests)
2	Basic Flight Operations	Takeoffs, Climbs, Maneuvers at Altitude, Descents, Approaches, Landings	Leading edges prepeeled (Failure mode tests)

9. All tests were conducted within the limits of the S-3B Operator's Manual (NATOPS), Naval Force Aircraft Test Squadron Operating Procedures, and local NAS Patuxent River Operating Procedures, references 2, 5, and 6, respectively. A detailed matrix of tests and test conditions is presented in table A-3. The flight test envelope and test configurations are presented in tables 2 and 3, respectively.

Table 2: Test Envelope

Parameter	Test Envelope	Aircraft Limit
Airspeed	0 to 330 KIAS	0 to 450 KIAS/ 0.79 IMN
Altitude	Surface to 15,000 ft	Surface to 40,000 ft MSL
Angle of Attack (AOA)	0 to 19 units	0 to 25 units
Symmetrical Load Factor	0.8g to 3.1g	-1.0g to +3.5g

Table 3: Test Configurations

Configuration	Name	Landing Gear Position	Flap Handle Position	Speedbrake Position	Thrust Setting(1)
CR	Cruise	Up	UP	Retracted	TLF
D	Descent	Up	UP	As Required	Idle
MAN	Maneuver	Up	MANUV	Retracted	TLF
TO	Takeoff	Down	TAKEOFF	Retracted	MRT
PA	Power Approach, Landing Flaps	Down	LDG	DLC(2)	TGS

NOTES: (1) As defined in table A-3 or TLF: Thrust for Level Flight; MRT: Maximum Rated Thrust; TGS: Thrust to maintain Glide Slope at 15 units AOA.
(2) DLC: Direct Lift Control engaged and activated as required.

METHOD OF TESTS

10. The test methods and procedures used are described within the Test and Test Conditions Matrix contained in table A-3. Coupons were installed by 3M personnel in accordance with reference 7. Deficiencies were assigned in accordance with the Flight Test and Engineering Group, Report Writing Guide, FTEG-TID-94-1-RWG, reference 8. Test team personnel performed preflight inspections of the appliqué at each test site to ensure there were no damaged sections prior to each flight. After each appliqué test flight was completed, test team personnel inspected the coupons at each test site for deformations. Any failures of the film were noted, measured, and photographed by test team personnel. Photographs were taken by authorized personnel in accordance with local instructions. For the initial flight, the appliqué material was said to have passed the tests if the coupons remained on the aircraft. For the prepeeled tests (flight 2), the adhesive side of the appliqué was treated to prevent its reattachment to the surface of the aircraft. This simulated a failure of the adhesive. The behavior of the section with this simulated

failure was examined, and any additional peeling or tattering of the section was noted. Tattering of peeled sections, rather than additional peeling, was desired.

CHRONOLOGY

11. The following is a chronology of this project's major milestones:

a.	Work Unit received	15 February 2000
b.	Test plan submitted	15 April 2000
c.	Test plan approved	17 April 2000
d.	Laboratory tests completed	27 March 2000
e.	Flight test started	1 May 2000
f.	Flight test completed	1 May 2000
g.	Report of Test Results submitted for review	7 June 2000

RESULTS AND EVALUATION

NONPEELED FLIGHT TESTS

12. Coupons were evaluated during varying aerodynamic loads to assess adhesive and film characteristics of the FP500 and FP1500 material with 52-4 adhesive. Configurations were CR, D, TO, and LAND. Altitudes ranged from the surface to 15,000 ft MSL and airspeeds from 0 to 350 KIAS. High lift devices as well as landing gear and bomb bay doors were cycled in flight to provide additional changes to aerodynamic loads on the test sites. Following the initial test flight, all sites were inspected. The FP500 and FP1500 film with 52-4 adhesive remained intact and attached to the surface of the aircraft skin as applied. The excellent adhesive characteristics of the 52-4 compound that maintains the appliqué film on the skin of the aircraft will promote reliable performance of FP500 and FP1500 appliqué material reducing corrosion and maintenance down time. The FP500 and FP1500 film materials with 52-4 adhesive are satisfactory for large-scale coupon testing.

PREPEELED (FAILURE MODE) FLIGHT TESTS

13. Coupons were evaluated during varying aerodynamic loads to assess the failure modes (the behavior of the appliqué following a failure during flight) of the FP500 and FP1500 material and 52-4 adhesive. Configurations were CR, D, TO, and LAND. Altitudes ranged from the surface to 15,000 ft MSL and airspeeds from 0 to 350 KIAS. High lift devices as well as landing gear and bomb bay doors were cycled in flight to provide additional changes to aerodynamic loads on the test sites. For these tests, a free edge of designated coupons (table A-2) was peeled back approximately 1 in. and the exposed adhesive/film were treated to prevent reattachment to the aircraft skin. Following this flight test, all sites were again inspected. None of the prepeeled edges of either the FP500 or FP1500 coupons showed any evidence of additional peeling. Additionally, the prepeeled section of the coupons tattered as desired. This behavior will prevent a small failure of the appliqué from growing to a catastrophic failure of the appliqué (defined as an entire section of appliqué peeling off the aircraft). The tattering, vice peeling, characteristic during failure of the FP500 and FP1500 material is an enhancing characteristic that should be incorporated into future appliqué systems.

ADHESIVE CHARACTERISTICS DURING FILM REMOVAL

14. The adhesive characteristics of the 52-4 compound were evaluated upon removal of the appliqué material following flight testing. When the appliqué was pulled off the surface of the aircraft, it was noted that no adhesive residue remained on the surface of the aircraft after the appliqué had been pulled off. This facilitated a rapid removal of the appliqué by eliminating the need to clean the surface of the aircraft to remove any adhesive residue after the appliqué had been removed. The strong adhesion between the 52-4 adhesive and the FP500 and FP1500 film materials prevented adhesive from remaining on the surface of the aircraft after appliqué removal and is an enhancing characteristic that should be incorporated in future appliqué systems.

SUPPORTING DATA

GENERAL

15. Flight test data were recorded via hand-held note cards and digital photography prior to and after each flight. No data was acquired during the flight tests. A digital camera was used for all photographs. Quantitative data were taken during appliqué installation to include 180 deg peel tests and surface roughness surveys. The 180 deg peel tests were performed with a stop watch and 30 lb force gauge. Surface roughness survey was measured using a Federal Products Co., Pocket Surf model EDM-1500-311 Surface Roughness Gage. Data accuracy is presented in table 4.

Table 4: Data Accuracy

Parameter	Error
Time	± 0.1 sec
Force	± 0.1 lb
Roughness	± 0.1μin.
Distance	± ¼ in.

FILM INSTALLATION

16. The appliqué material, FP500 and FP1500 with 52-4 adhesive, was applied to the three sites. The coupon test sites are listed in table A-2 and shown in figure B-1. They were first painted with self-priming topcoat (TT-P-2756), "Unicoat," and allowed to dry at least 2 weeks before the appliqué material was applied. Scotch-brite™ pads, isopropyl alcohol, and cheesecloth were used to clean the surface at each test site. The average surface roughness was obtained by taking the average of six to nine readings. The average 180 deg peel adhesion, for both the 5 min dwell and the extended dwell, were obtained by taking the average of 8 readings at 12 in./min using a pull scale on 1 x 8 in. strips of appliqué. The results of the surface roughness measurements and 180 deg peel adhesion measurements can be found in figure B-2.

INITIAL TEST

SITE 1: UNDERSIDE WING SURFACE

17. Six coupons in a 2 x 3 pattern were applied at site 1, with the FP500 material on the left row and the FP1500 material on the right row (looking forward). Unperforated coupons were applied to the site on the left wing, and perforated coupons were applied to the site on the right wing. Figure 1 shows the coupons at site 1 on the left wing prior to flight, and figure 2 shows the coupons at site 1 on the right wing prior to flight. Following the initial test flight, both the FP500 and FP1500 coupons remained attached to the surface of the aircraft, and did not show any signs of deformation or failure. The coupons appeared as they did prior to the flight; therefore, no photographs were taken of the coupons at site 1 following the flight.

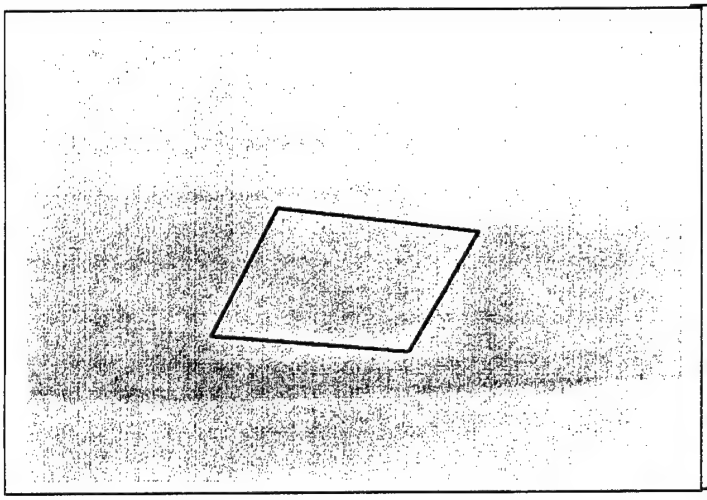

Figure 1: Coupons at site 1 on the left wing prior to flight. (Test site outlined in black.)

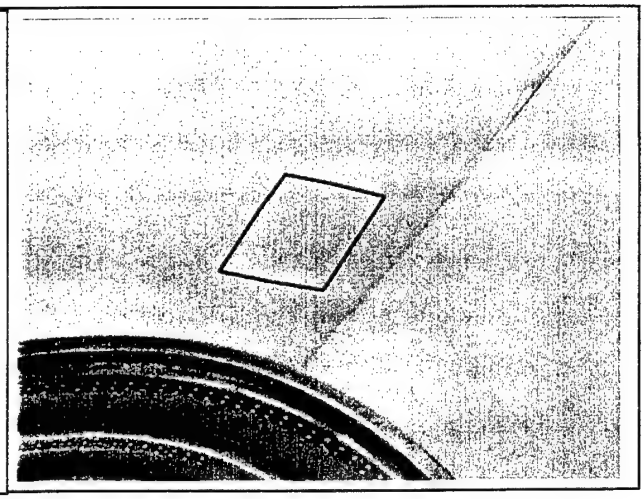

Figure 2: Coupons at site 1 on the right wing prior to flight. (Test site outlined in black.)

SITE 2: MAIN LANDING GEAR DOOR

18. Six coupons in a 2 x 3 pattern were applied at site 2, with the FP500 material on the left row and the FP1500 material on the right row (looking forward). Unperforated coupons were applied to the site on the left lower door, and perforated coupons were applied to the site on the right lower door. Figure 3 shows the coupons at site 2 on the left lower door prior to flight, and figure 4 shows the coupons at site 2 on the right lower door prior to flight. Following the initial test flight, both the FP500 and FP1500 coupons remained attached to the surface of the aircraft, and did not show any signs of deformation or failure. The coupons appeared as they did prior to the flight; therefore, no photographs were taken of the coupons at site 2 following the flight.

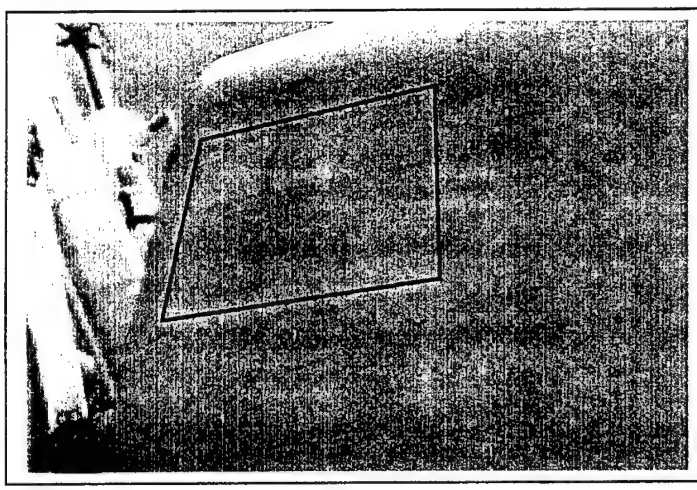

Figure 3: Coupons at site 2 on the left lower gear door prior to flight. (Test site outlined in black.)

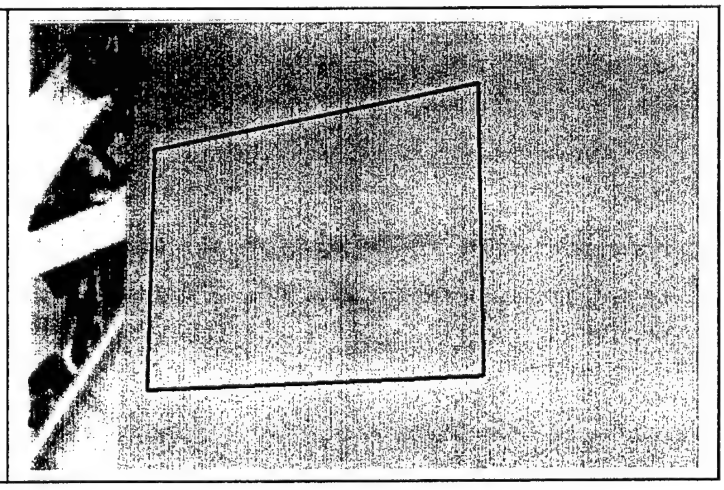

Figure 4: Coupons at site 2 on the right lower gear door prior to flight. (Test site outlined in black.)

SITE 3: VERTICAL TAIL BELOW RUDDER

19. Eight coupons in a 2 x 4 pattern were applied at site 3, alternating between the FP500 and FP1500 material in a checkerboard pattern. Only unperforated coupons were applied. Figure 5 shows the coupons at site 3 prior to flight. Following the initial test flight, both the FP500 and FP1500 coupons remained attached to the surface of the aircraft, and did not show any signs of deformation or failure. The coupons appeared as they did prior to the flight; therefore, no photographs were taken of the coupons at site 3 following the flight.

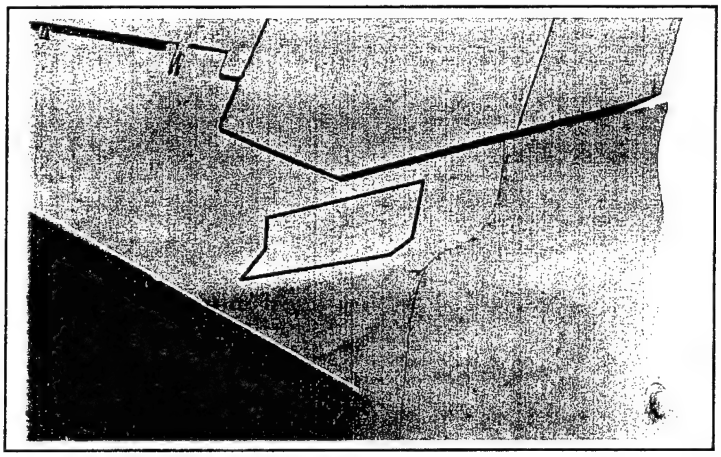

Figure 5: Coupons at site 3 on the vertical tail below the rudder prior to flight. (Test site outlined in black.)

FAILURE MODE TEST

GENERAL

20. The second test flight was conducted to study the failure modes of the appliqué (the behavior of the appliqué following a failure during flight). To simulate a failure, prior to the flight, an edge of the coupons was peeled back 1 in. in accordance with table A-2. The adhesive on the peeled section was treated to prevent the appliqué from readhering to the surface of the aircraft.

SITE 1: UNDERSIDE WING SURFACE

21. The leading edge of the two forward-most coupons was peeled back at site 1 on the left and right wings. Figure 6 shows the prepeeled coupons at site 1 on the left wing prior to flight, and figure 7 shows the prepeeled coupons at site 1 on the right wing prior to flight.

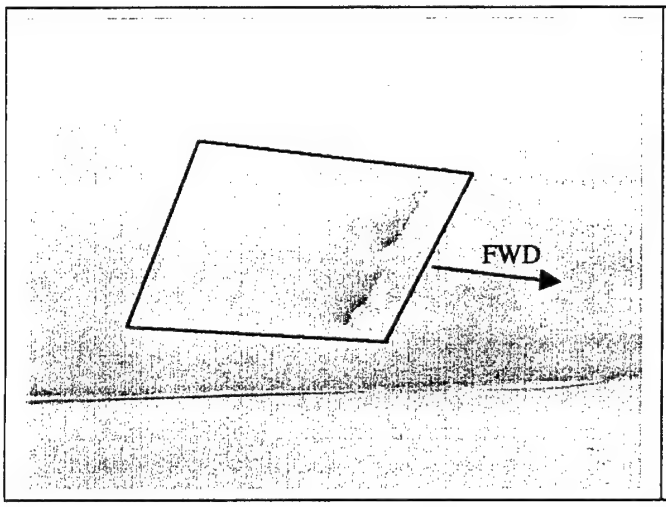

Figure 6: Prepeeled coupons at site 1 on the left wing prior to flight. (Test site outlined in black.)

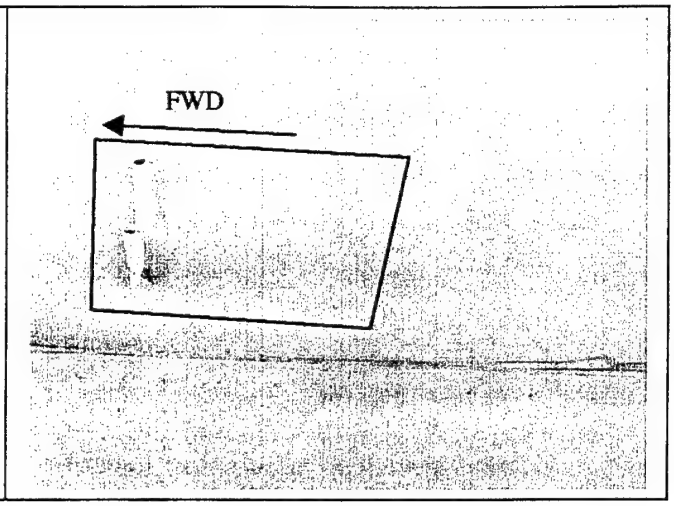

Figure 7: Prepeeled coupons at site 1 on the right wing prior to flight. (Test site outlined in black.)

Following the failure mode test flight, the prepeeled coupons at site 1 were inspected. Figure 8 shows the prepeeled coupons at site 1 on the left wing following the flight, and figure 9 shows the prepeeled coupons at site 1 on the right wing following the flight. Neither the FP500 nor FP1500 material experienced any additional peeling, and the film tattered as desired.

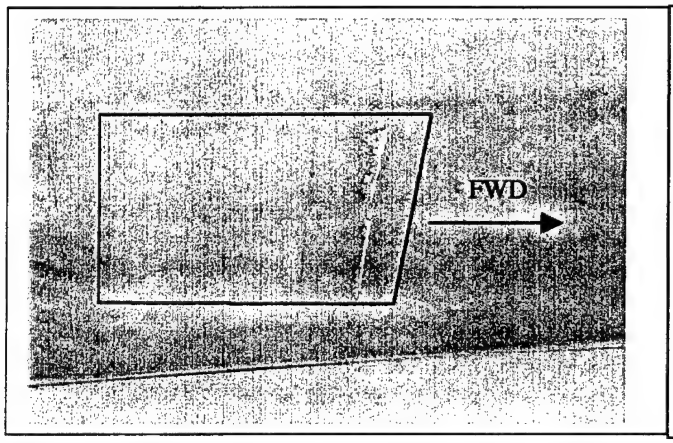

Figure 8: Prepeeled coupons at site 1 on left wing following flight. (Test site outlined in black.)

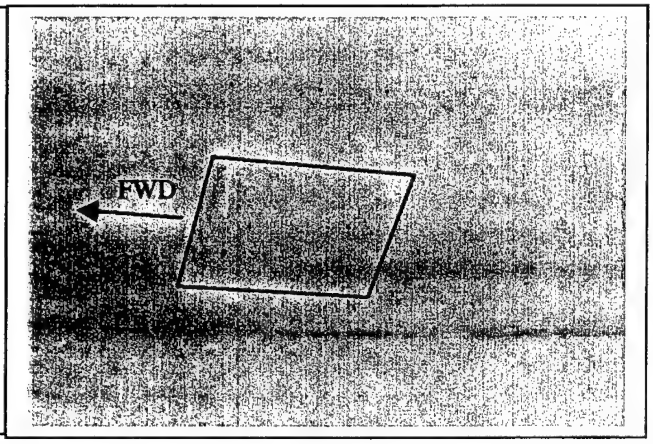

Figure 9: Prepeeled coupons at site 1 on right wing following flight. (Test site outlined in black.)

SITE 2: MAIN LANDING GEAR DOOR

22. The leading edge of the two forward-most coupons was peeled back at site 2 on the left and right lower gear doors. Figure 10 shows the prepeeled coupons at site 2 on the left door prior to flight, and figure 11 shows the prepeeled coupons at site 2 on the right door prior to flight.

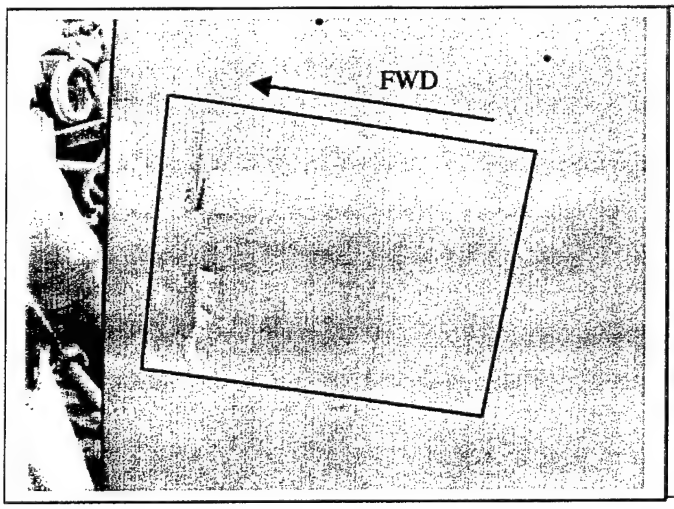

Figure 10: Prepeeled coupons at site 2 on the left lower gear door prior to the flight. (Test site outlined in black)

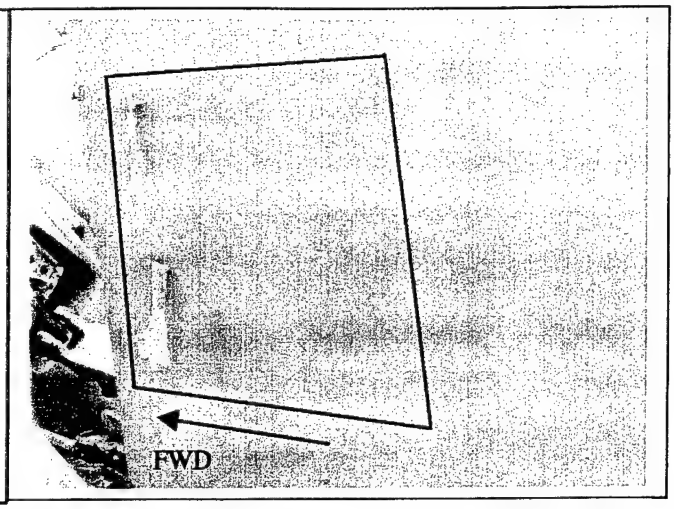

Figure 11: Prepeeled coupons at site 2 on the right lower gear door prior to flight. (Test site outlined in black)

Following the failure mode test flight, the prepeeled coupons at site 2 were inspected. Figure 12 shows the prepeeled coupons at site 2 on the left lower gear door following the flight, and figure 13 shows the prepeeled coupons at site 2 on the right lower gear door following the flight. Neither the FP500 nor FP1500 material experienced any additional peeling, and the film tattered as desired.

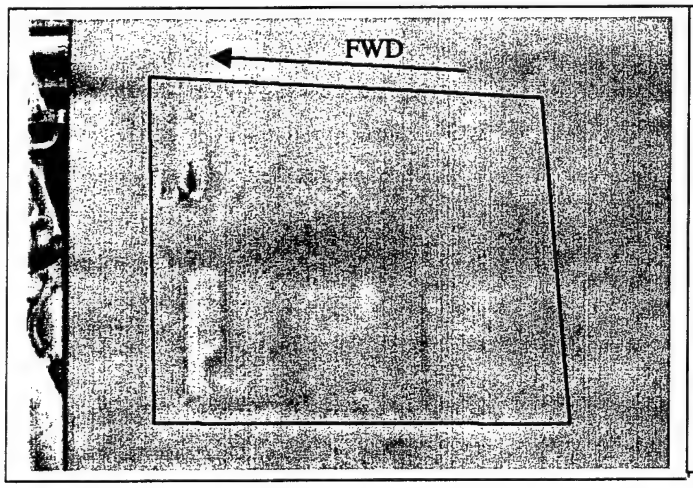

Figure 12: Prepeeled coupons at site 2 on the left lower gear door following the flight. (Test site outlined in black.)

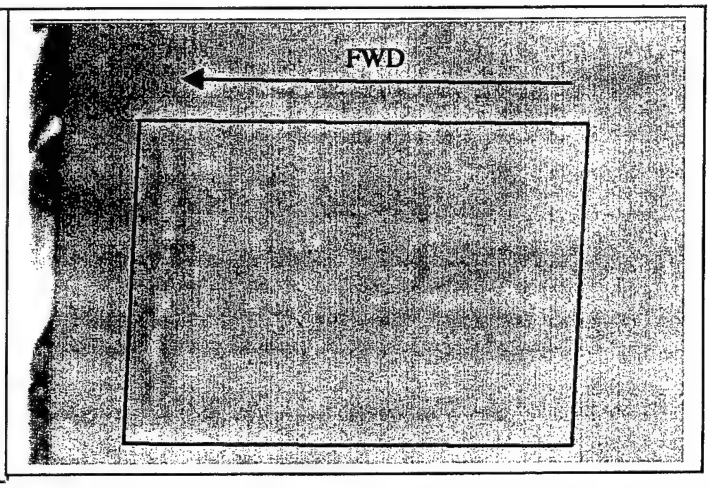

Figure 13: Prepeeled coupons at site 2 on the right lower gear door following the flight. (Test site outlined in black.)

SITE 3: VERTICAL TAIL BELOW RUDDER

23. The leading edge of the two forward-most coupons, and the upper edge of the upper-most aft coupons were peeled back below the rudder. Figure 14 shows the prepeeled coupons at site 3 below the rudder prior to flight.

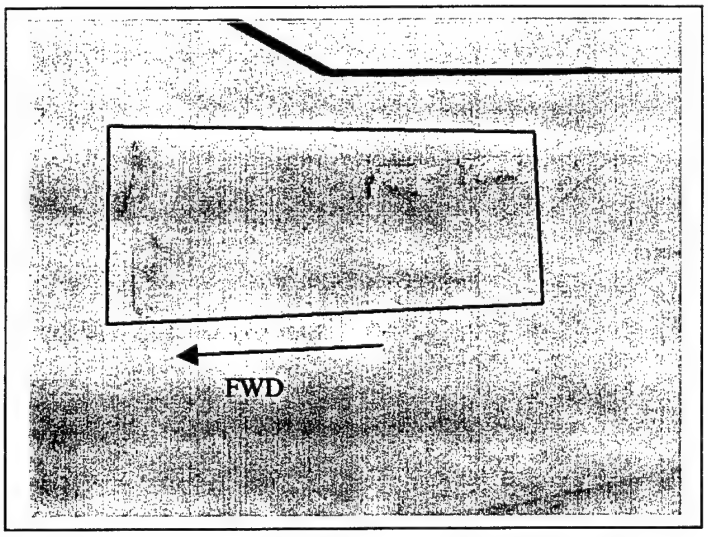

Figure 14: Prepeeled coupons at site 3 on the vertical tail below the rudder prior to flight.

Following the failure mode test flight, the prepeeled coupons at site 3 were inspected. A photograph showing the prepeeled coupons at site 3 following the flight was not available. However, neither the FP500 nor FP1500 material experienced any additional peeling, and the film tattered as desired.

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CONCLUSIONS

GENERAL

24. The FP500 and FP1500 appliqué materials with 52-4 adhesive are satisfactory for continued large-scale testing.

ENHANCING CHARACTERISTICS

25. Tattering, vice peeling, characteristic during failure of the FP500 and FP1500 materials (paragraph 13).

26. Strong adhesion between the 52-4 adhesive and the FP500 and FP1500 film materials prevented adhesive from remaining on the surface of the aircraft after appliqué removal (paragraph 14).

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RECOMMENDATIONS

GENERAL

27. Incorporate the enhancing characteristics in paragraphs 25 and 26 in future appliqué systems.

28. Proceed with large-scale appliqué coupon testing using FP500 and FP1500 appliqué material with 52-4 adhesive.

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REFERENCES

1. PMA-290C1, Team Work Plan No. 290C1/00-8/290C1-05, of 15 Dec 1999.

2. NAVAIR 01-S3AAB-1, NATOPS Flight Manual, Navy Model S-3B Aircraft, of 1 Nov 1997.

3. 3M document, "Aircraft Appliqué Lab Test Results," of 23 Mar 2000.

4. NAVAIR document, "S-3 Evaluation, 52-4 Adhesive," of Mar 2000.

5. Naval Force Aircraft Test Squadron Operating Procedures, 3710.1H, of 7 Dec 1999.

6. Naval Test Wing Atlantic General Flight and Operating Instructions, 3710.1A, of 3 Nov 1998.

7. 3M document, "S-3B Appliqué Small Coupon Flight Test," of 17 Feb 2000.

8. Flight Test and Engineering Group, Report Writing Guide, FTEG-TID-94-1-RWG, of 1 Mar 1994.

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APPENDIX A
TABLES

Table A-1: Material Performance Lab Tests

Test Type	Test Description
Adhesion Tests	72°F (Peel)[1]
	140°F for 10 min minimum soak (Peel)[1]
	180°F for 10 min minimum soak (Peel)[1]
	35°F for 10 min minimum soak (Peel)
	-25°F for 10 min minimum soak (Peel)
	-40°F for 10 min minimum soak (Peel)[1]
	-65°F for 10 min minimum soak (Peel)[1]
	Scrape Adhesion
	Wet tape test ASTM D3359 for 24 hr (RT), 4 days at 120°F, and 7 days at 150°F
	Film-to-Film Adhesion
	Impact Flexibility[1]
	Impact Flexibility, after 4 hr at 250°F
	Impact Flexibility, after 4 hr at -65°F
	Impact Flexibility, after 500 hr weatherometer
	Impact flexibility, after 24 hr lubrication oil (MIL-L-23699) at 250°F
	Low Temperature Flexibility 1 in. mandrel bend at -65°F[1]
Fluid Resistance Tests	Lubricating oil (MIL-L-23699) at 250°F for 24 hr[1]
	Hydrocarbon Soak (TT-S-735 Type III) for 7 days[1]
	JP-5 for 7 days[1]
	S-3 Hydraulic Fluid (MIL-H-83282) at 150°F for 24 hr[1]
	Turbine Wash (MIL-C-85704) at 100°F for 24 hr[1]
	Deionized water at 100°F for 4 days[1]
	Aircraft wash (MIL-C-85570 Type I) for 7 days
	Radar Coolant (MIL-PRF-87252) for 7 days
	Waterless Cleaner (MIL-C-43616) for 7 days
Corrosion Tests	2,000 hr Salt Spray - scribed panel (ASTM B 117)[2]
	500 hr SO_2 Salt Spray - scribed panel (ASTM G 85.A4)[2]
Weathering Tests	Tensile and abrasion at room temperature
	30 day Humidity
	1,000 hr Weatherometer intervals of 14, 28, and 42 days[2]
	2,000 hr Salt Spray – ASTM B 117 intervals of 28, 42, and 84 days[2]
	500 hr SO_2 Salt Spray ASTM G 85.A4 intervals of 7, 14, and 21 days[2]

NOTES: (1) Test required to be completed prior to appliqué coupon installation for coupon flight test. See references 2 and 3 for test results.

(2) Test required to be started, but not required to be completed, prior to appliqué installation for full-scale flight test.

Table A-2: S-3B Small-Scale Appliqué Coupon Test Site Locations

Site	Location	Coupon Description	Location of Prepeeled Edges for Failure Mode Analysis
1	Underside wing surface between fuselage and engine pylon (fore and aft against each pylon) (both sides)	Size: 3 x 3 in. Type: Unperforated on left, perforated on right Lay up: 6 coupons in a 2 x 3 pattern with FP500 material on left row and FP1500 on right row (see figure C-3)	Leading edge of two forward-most coupons prepeeled
2	Main landing gear door, L/R door, aft doors both sides	Size: 3 x 3 in. Type: Unperforated on left, perforated on right Lay up: 6 coupons in a 2 x 3 pattern with FP500 material on left row and FP1500 on right row (see figure C-3)	Leading edge of two forward-most coupons prepeeled
3	Vertical tail above horizontal stabilizer, below rudder, left side	Size: 3 x 3 in. Type: Unperforated Lay up: 8 coupons in a 2 x 4 pattern, alternating FP500 and FP1500 material in a checkerboard pattern (see figure C-3)	Leading edge of two forward-most coupons prepeeled Upper edge of two upper-most aft coupons prepeeled

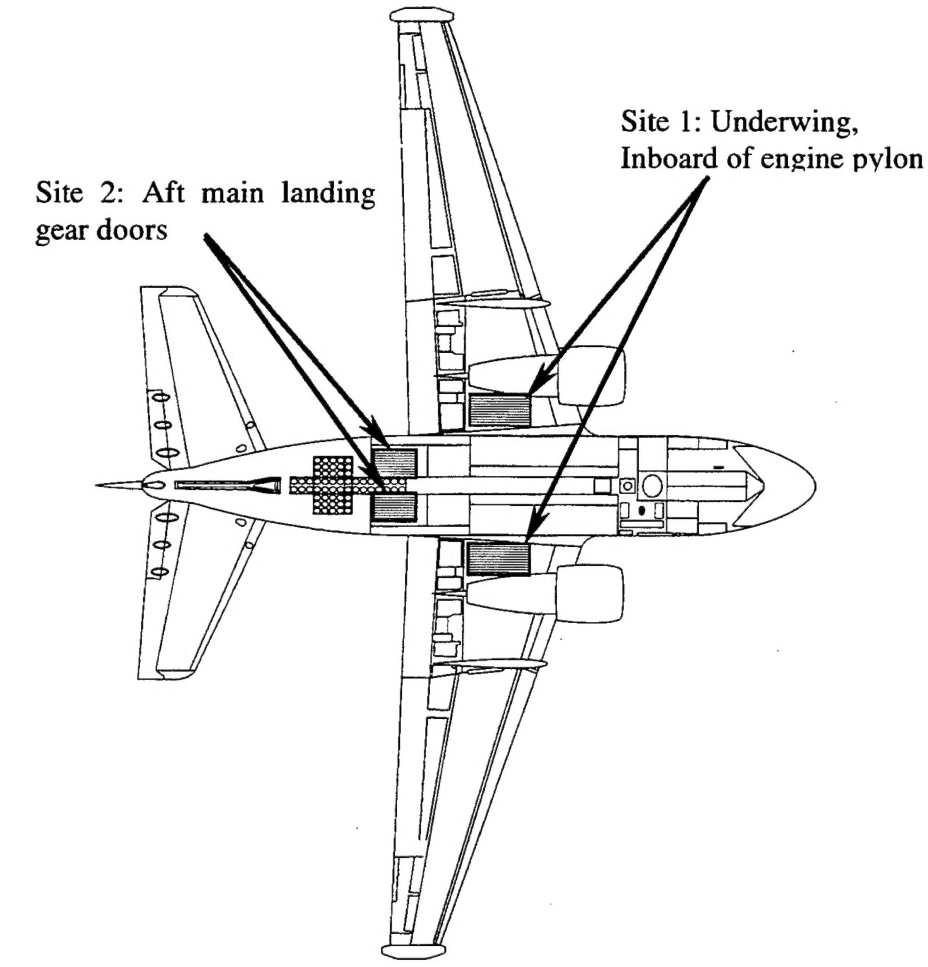
Table A-3: Tests and Test Conditions

Test No.	Test Description	Config[1]	Thrust[2]	Altitude (ft MSL)	Airspeed (KIAS)	Method/Data/Remarks
	Initial Flight Tests					
1	Normal Takeoff	TO	MRT	SFC to 1,000	0 to 130	❑ Performed standard NATOPS takeoff.
2	Climb	CR	MCT	1,000 to 15,000	220 to 250	❑ Performed intermediate power climb
3	Sideslip	CR	TLF	15,000	200	❑ Performed SHSS (1/2 rudder) for minimum 60 sec to left and right.
4	Bank to Bank Rolls	CR	TLF	15,000	350	❑ Performed rapid bank to bank rolls (±45 deg AOB) a minimum of five times.
5	High AOA Flight	CR	TLF	Above 15,000	NMT 20 units	❑ Performed sustained high AOA flight (above 17 units) for minimum 60 sec.
6	Tactical Descent	D	Idle	10,000 to 5,000	190	❑ Performed tactical descent from altitude using speed brakes and no more than 15 units.
7	Cycle Bomb Bay Doors	CR	TLF	5,000	300	❑ Cycled bomb bay doors a minimum of two times.
8	Carrier Break	CR→PA	A/R	1,500	300 to 130	❑ Performed normal carrier break and dirty up.
9	Normal Landings	PA	TGS	1,000 to SFC	15 units	❑ Performed normal landings.

[1] Configuration CR: gear up, flaps up, speed brakes retracted; D: gear up, flaps up, speed brakes extended; TO: gear down, LE flaps DN (25 deg), TE flaps 65% (25 deg), speed brakes retracted, DLC engaged; PA: gear down, LE flaps DN (25 deg), TE flaps 100% (35 deg), speed brakes retracted; DLC engaged.

[2] MRT: Maximum Rated Thrust; MCT: Maximum Continuous Thrust; TLF: Thrust for Level Flight; TGS: Thrust to maintain Glide Slope at 15 units AOA.

APPENDIX B
FIGURES



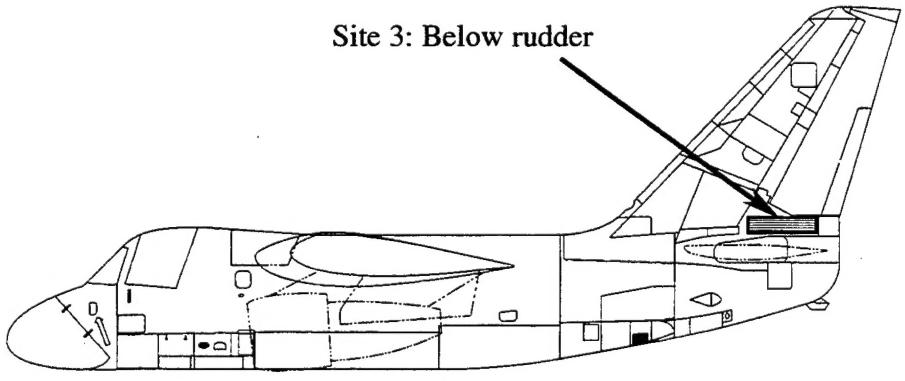
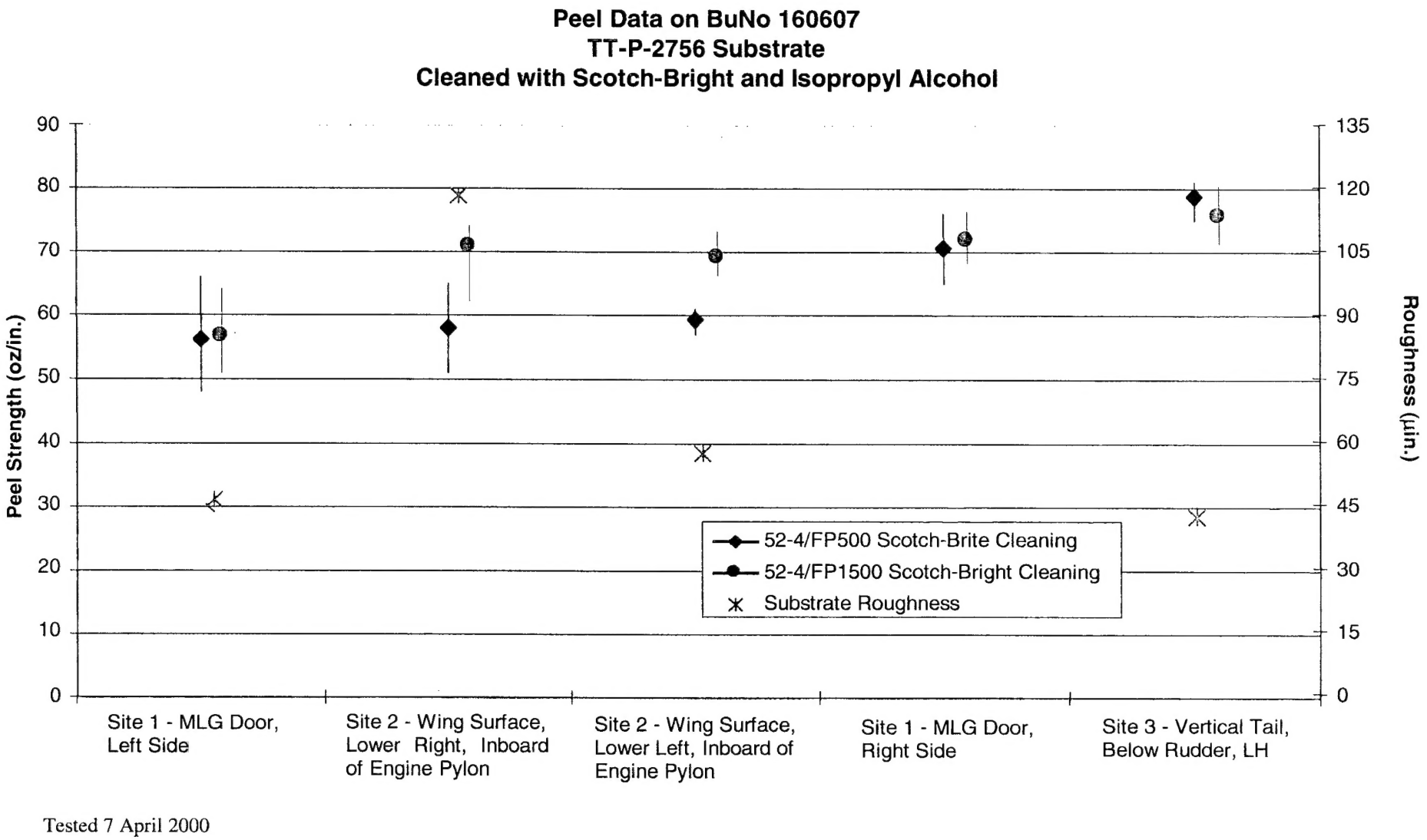
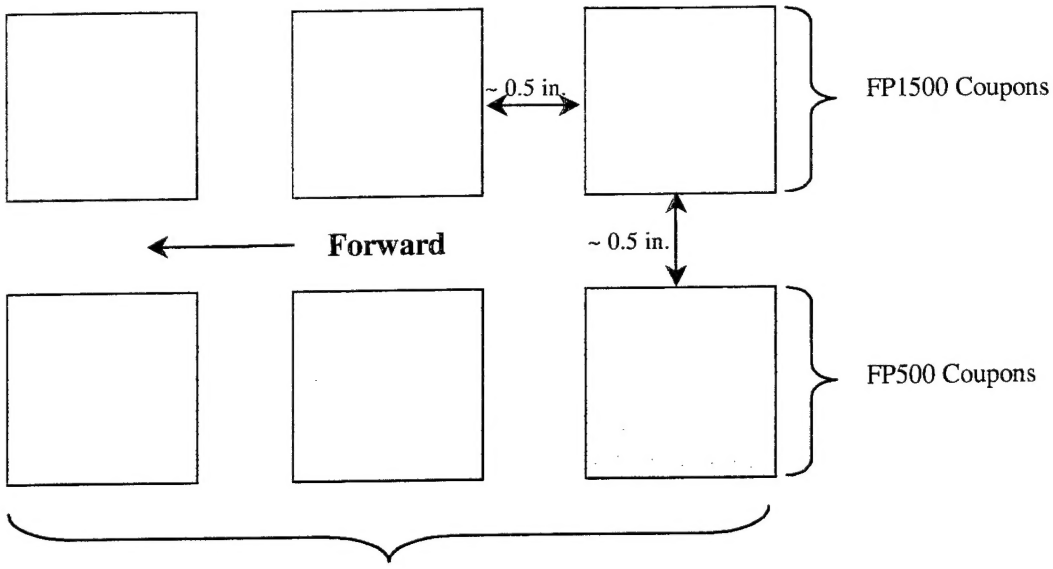


Figure B-1: Coupon Test Site Locations



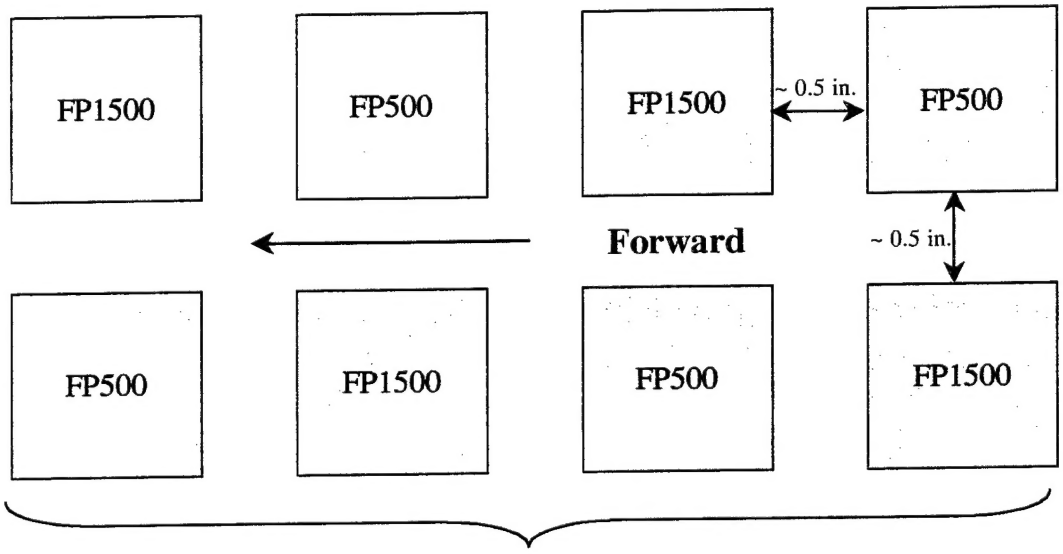
Tested 7 April 2000

Figure B-2: Surface Characterization and Peel Strengths



Six 3 x 3 in. Small-Scale Coupons

Figure 3a: Sites 1 and 2



Eight 3 x 3 in. Small-Scale Coupons

Figure 3b: Site 3

Figure B-3: Installation Scheme of Coupons

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